PG&E Comments on

California Coastal Power Plants
Cost and Engineering Analysis of Cooling System Retrofits
Draft Prepared by Tetra Tech

1. OVERVIEW:

PG&E appreciates the opportunity to provide comments on Tetra Tech's draft report: Cost and Engineering Analysis of Cooling System Retrofits. While PG&E is committed to the use of non-OTC technologies at new facilities, we have two remaining OTC plants: Humboldt and Diablo Canyon. We are in the process of obtaining final approval to repower our Humboldt plant using dry cooling, and thus, our expectation is that Diablo Canyon will be our only OTC facility within the next few years.

Given the limited amount of time and the unavailability of the technical information supporting many of the draft report's conclusions, we are precluded from performing an in-depth analysis of Tetra Tech's work. However, we have identified many issues that warrant considerable additional investigation and research before a definitive determination that a retrofit is technically feasible could be reached.

Our concerns may be summarized in three broad categories: Engineering issues, adverse environmental impacts, and cost issues.

Engineering

From an engineering perspective, our concern is that there are very few facilities in the country with salt water cooling towers and no existing nuclear facilities with mechanical draft salt water towers. Additionally, a retrofit of the size and complexity of Diablo Canyon has never been undertaken. Thus, there is absolutely no precedent for assessing the feasibility of such a retrofit. As described in more detail below, the draft report raises many critical engineering and technical issues, but does not adequately evaluate these issues in reaching its conclusion that cooling towers may be feasible at the site. Given the lack of experience with salt water towers at a nuclear facility, it is all the more important that significant engineering and nuclear safety issues be thoroughly analyzed before making any determination of technical feasibility. NRC regulations require any significant modification such as this to be analyzed to determine its impact on nuclear safety. Prior NRC review and approval of any such modification would likely be required.

Environmental Impact

The installation of cooling towers will trigger several significant adverse environmental impacts that are also inadequately assessed in the report. These include impacts to facility and grid stability from salt drift, the treatment necessary for the remaining power plant systems discharge and cooling tower blowdown (over 72 million gallons per day), and the enormous Green House Gas (GHG) implications for both the shutdown period of 12 to 18 months and the 100 MW energy penalty due to decreased plant efficiency.

Cost Issues

Further, the draft report significantly understates the cost of a retrofit as the shutdown costs are calculated using a merchant-based model which is inappropriate for PG&E, and capital costs are likely underestimated due to inadequate evaluation of many identified technical issues.

It is important to note that the report's regulatory section does not fully address or acknowledge some key players in the retrofit permitting process. It does not include any discussion of the role of NRC requirements and licensing processes or the role of the Cal-ISO in ensuring a stable, reliable electric supply for the state. While the report acknowledges the difference between a retrofit and repowering, the regulatory section focuses heavily on requirements that drive new facility construction and the repowering of facilities—not a retrofit of an existing facility. It should also be noted that the State Lands Commission's April 2006 resolution was overturned by the Office of Administrative Law.

2. COMMENTS ON CHAPTER 7C — DIABLO CANYON POWER PLANT

Comments on Section 2.0 — Background

In order to ensure a better understanding of the existing situation at Diablo Canyon, it is necessary to provide a number of corrections and clarifications.

- The plant does not use heat treatment and has not done so since 1989.
- The plant's NPDES permit is in administrative extension. The permit referenced in the report was proposed by Board staff in 2003, but never adopted by the Board.
- The industrially zoned site is 585 acres, not 750 acres.
- The NRC licenses run through 2024 and 2025 respectively for Units 1 and 2.
- The plant's intake system was designed to minimize impingement.

Also, the report greatly simplifies the permitting challenges for a cooling tower installation, as a workable installation would likely include not only the monumental task of designing and building the towers, but the potential necessity of undergrounding the 500kV transformers and transmission lines, the relocation of the 98,000 square foot warehouse, displacement of already limited vehicle parking areas, and significant modification of various other plant systems. Approvals would be needed from the NRC, CPUC, the California Coastal Commission, the Regional Water Quality Control Board, and the San Luis Obispo County Air Pollution Control District.

Comments on Section 3.0 — Wet Cooling System Retrofit

Comments on Section 3.2 — Design Basis

Condenser Specifications

Tetra Tech states that some modifications to the condenser (tube sheet and water box reinforcement) may be necessary to handle the increased water pressures that will result from the increased total pump head required to raise water to the elevation of the cooling tower riser. No provisions are included to re-optimize the condenser performance for service with a cooling tower. Tetra Tech states, "If wet cooling towers were installed, DCPP, as a facility with a projected remaining life span of 15 years or more (currently licensed to operate through 2021 and 2025 for Units 1 and 2), would likely pursue an overall strategy that included re-optimizing the condenser to minimize performance losses resulting from a conversion." We believe Tetra Tech is understating the required modification to the condenser to make it suitable for a cooling water operating pressure (nominally 50 PSIG) of twice the present waterbox design pressure and roughly five times the present operating pressure. With no provided basis, Tetra Tech states that modifications are generally limited to reinforcement measures to enable the condenser to withstand the increased pressures. We believe that the required modifications to the condenser, even without thermal optimization, would be major both from a cost standpoint and a construction duration standpoint.

The present condenser has a history of tube leaks which would be made worse by significantly increasing the water box pressures. These tube leaks have required the plant to shutdown which has the potential to adversely impact plant safety. The present condensers have 2 to 3% of their tubes plugged due to leakage. Increased tube leaks would have an adverse impact on the operation of the condensate polishers and potentially an adverse impact on transient feedwater and main steam chemistry. Secondary side water chemistry is an important aspect of nuclear safety due to potential degradation of steam generators and main turbines (missile generation) and potential plant trips. Plant trips due to chemistry excursions unnecessarily exercise plant safety systems. Transient departures from water and steam chemistry limits would, as a minimum, impact the steam generator and main turbine warranties. None of these issues were addressed in the Tetra Tech report.

Although the limited time for this review precluded an in-depth investigation of these issues, it is our judgment that such an investigation would conclude that replacement of the present waterboxes, tube sheets and tubes with a modular design and welded tube-to-tube sheet joint would be required. This would be a major undertaking with significant impact on both the cost and downtime. We agree with Tetra Tech that re-optimization would require extensive demolition and excavation of the existing site to gain access to the existing condensers (on the lower level of the turbine building) and reconfigure the tubes and supply and return lines connecting to the water boxes. The Tetra Tech report states, "Because of the complexity and level of detail required to develop an accurate estimate of a condenser re-optimization for DCPP, no attempt is made to characterize the cost or impact on facility downtime during construction in this study."

Plume Abatement

The Tetra Tech report states, "The proximity of DCPP to coastal recreational areas, and the potential visual impact on these resources, may require plume abatement measures. California Energy Commission (CEC) siting guidelines and Coastal Act provisions evaluate the total size and persistence of a visual plume with respect to aesthetic standards for coastal resources; significant visual changes resulting from a persistent plume would likely be subject to additional controls." Yet the report finishes its discussion on the subject by saying, "Plume-abated towers are not included in the design for DCPP. If they are required, limitations on space may become more restrictive than they already are for the conventional cooling towers designed for this study."

We believe it is highly likely that plume abatement measures would be required by the permitting agencies. Thus, plume-abated towers and the associated need for additional required space must be included in the study prior to making any determination of feasibility.

Facility Configuration and Area Constraints

As indicated in the background, the parcel zoned industrial is only 585 acres, not the 750 cited. It is unclear whether this loss of acreage changes the analysis, particularly given the likely need for more space if plume-abated towers are required. Further, the report contains little or no discussion of the significant earth moving required to grade sufficient space for tower placement. Prior review by Burns Engineering indicated that the proposed tower placement would require excavation of a 1600 x 600 foot section of the adjacent mountain. Additionally, there is no discussion about the feasibility of the required 60-foot deep-pile foundations that would be necessary to ensure a stable foundation.

Location of the New Pump House

The location of the new Pump House as shown in Figure C-6 blocks access to the Turbine Building crane bay where all large pieces of machinery (turbine rotors, generators, pumps, etc) enter and exit the building. Its proposed location is technically unacceptable.

Relocation and Impact of Various Support Structures

Due to the extremely limited space available on the DCPP site, the Tetra Tech study acknowledges that any retrofit project that incorporated a closed-cycle system would require the relocation of significant support structures such as the 98,000 square foot main warehouse and parking lots to other areas that are not available within the portion of the property that is zoned for industrial development. The relocation of the warehouse would have a significant impact on the cost and feasibility of a cooling tower retrofit. It would have significant impacts operating costs, nuclear security, and permitting issues as well as possible nuclear safety issues due to delay in availability of replacement parts. The Tetra Tech study does not address the impact of these issues, stating, "Off-site relocation of parking areas and support services, if feasible, would increase project costs and are beyond the scope of this study."

Comments on Section 3.3 — Conceptual Design

Flooding Threat to Nuclear Safety

The proposed cooling tower project would invalidate an NRC-approved turbine building flood safety analysis and pose an increased threat to nuclear safety. The possibility of a leak in the Circulating Water System poses a threat to safety-related components in the turbine building, especially the safety related emergency diesel generators (EDGs). The present Circulating Water Pumps (CWPs) trip on high-condenser pit levels to minimize the consequences of a flooding event, such as would be caused by loss of a condenser waterbox manway cover.

The following documents discuss our licensing commitments in this area.

FSAR Section 10.4.5.4, "Flooding," describes a flooding analysis performed on circulating water leakage due to an improperly secured condenser waterbox manway cover. The FSAR credits the CWP trip on high condenser pit level for eliminating the need for operator action to protect the safety related EDGs from circulating water system leakage.

Supplement 7 to the Safety Evaluation Report (SSER 7), Section 10.4, "Other Features," states that the only safety-related equipment that would be vulnerable to circulating water system flooding would be the diesel generators. SSER 7 states that an automatic trip system has been installed for the circulating water pumps that eliminates the need for the operator to take rapid corrective action in the event of a large circulating water leak, and that the NRC staff finds it acceptable.

The installation of cooling towers would greatly increase the threat due to flooding and would require further analysis and most likely NRC approval. If the present once-through system developed a leak (such as that due to an improperly secured condenser waterbox manway cover), the water level would build up in the turbine building sump and level switches would trip the CWPs. Because the elevation of the present circulating water conduits are below the elevation of the leak, the flooding into the turbine building would stop after the circulating water pumps stop. However, with the evaluated wet cooling towers, large quantities of piping and the cooling tower basin are located above the elevation of the leak. Therefore, even after the new CWPs were tripped, the water inventory above the elevation of the leak (roughly 10 million gallons) would drain into the turbine building. The volume of water is such that, if contained, it could fill the Unit1 or Unit2 turbine building to a hypothetical depth of over 20 feet and impact a variety of safety-related equipment, including the EDGs.

This issue is not addressed by Tetra Tech, would require significant analyses and could result in a condition the NRC would be unwilling to license.

<u>Replacement of Service Cooling Water Heat Exchangers and Condensate Coolers</u>

Inside the turbine building, the circulating water cools not only the Main Condenser but also the Service Cooling Water (SCW) heat exchangers and the Condensate Cooler for the Main Generator Hydrogen Coolers (to maintain generator gas temperature within limits). If the SCW heat exchangers would no longer be serviced by once-through seawater flow, significant issues arise due to the loss of low temperature inlet cooling water. The draft report does not provide any analysis of either maintaining system operability with existing design requirements or retrofitting this critical plant cooling system to effectively operate with closed-cycle cooling. Some of the issues associated with incorporating the system into a closed-cycle system are discussed below.

The increase of cooling water temperature by 17 to 20°F (as well as the increase in pressure) would necessitate replacement of both the SCW Heat Exchangers and the Condensate Cooler and possibly many of the components cooled by the SCW system.

The SCW system removes heat from various secondary system components via a closed loop cooling cycle and rejects the heat to the Circulating Water System. The closed loop SCW system presently runs with a cold end temperature on the order of 79°F (e.g. 58°F circulating water cools the service cooling water to 79°F). Even after replacing the heat exchanger with a much larger heat exchanger it will not be possible to cool the SCW to 79°F using 78°F circulating water from the cooling towers.

The heat loads cooled by the SCW System include:

- Main feed pumps turbine lube oil coolers
- Condensate booster pumps lube oil coolers
- Generator exciter
- Fuse wheel
- Generator seal oil coolers
- Iso-phase bus coolers
- Main turbine reservoir lube oil coolers
- Post LOCA sampling system room air conditioning and sample panel chiller
- Plant air compressors 05 and 06 (via the SCW booster pumps)
- Reciprocating air compressor jacket coolers and aftercoolers
- Air system air dryers
- TSC air conditioning units
- Personnel access control room air conditioning unit
- Operations ready room air conditioning unit
- Condenser vacuum pump seal water heat exchanger
- Electro-hydraulic control coolers
- Feedwater sample cooler 72
- #2 heater drain pump lube oil coolers and sample cooler
- Secondary process control room isothermal bath water chiller

In addition to the replacement of the SCW heat exchanger, many of the above components cooled by the SCW could require modification or replacement due to the higher SCW cooling water temperature. The Tetra Tech study does not address this major issue.

Constructability of Interconnecting Piping and New Pump House

Tetra Tech provides a very simplistic non-detailed description of the implementation of the new pump house and the interconnection of the new piping to the existing circulating water conduits. Figure C-6 shows Tetra Tech's simplified sketch of the pipe routing between the new pump house and the towers, but fails to address how and where the interconnection to existing supply and return conduits would be accomplished and the magnitude of the safety and non-safety related systems that would be severely impacted and would physically interfere with the design and the proposed construction.

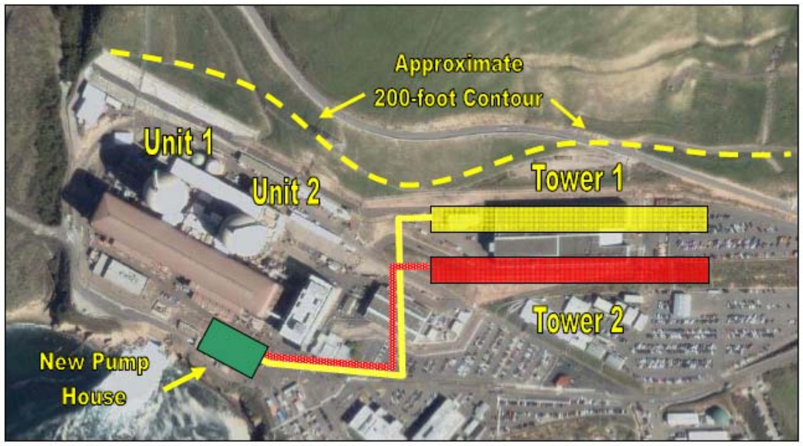
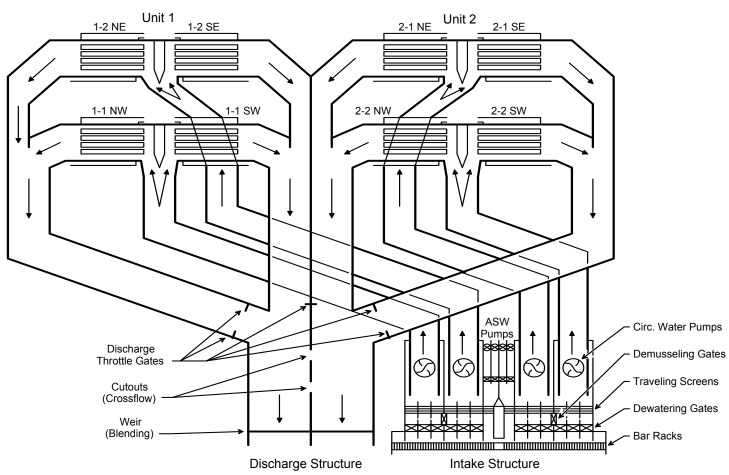


Figure C–6. Cooling Tower Locations

The following schematic shows the existing circulating water conduits to the condenser. Connections would have to be made to all the supply and return conduits including those coming from the north end of the Unit1 condenser. A review of detailed site drawings indicates that the excavations and routing required for these large-diameter connections would be an extremely difficult, if not impossible, engineering task .



The limited area for this inter-tie in front of the turbine building is extremely congested with both safety-related and non-safety-related systems, piping and conduits.

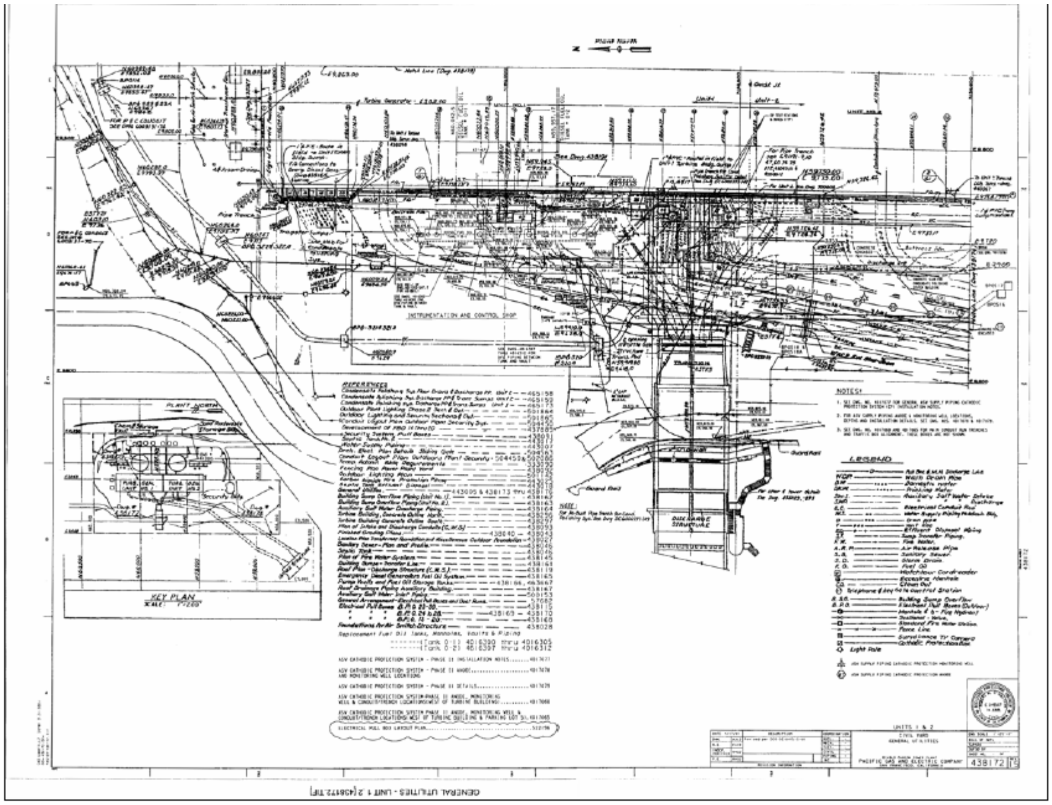


FIGURE 6 - Plan View of Tie- in Underground Construction Conditions in Front of Turbine Building

The Tetra Tech study does not sufficiently address if it is even possible to route the large diameter piping in this area, nor the disruption of the numerous systems that would have to be relocated to accomplish this construction. The safety-related ASW system bisects this area and is required to remain in operation even with both units shut down. The difficulty, time and cost associated with these excavations, tie-ins and system interferences is immense. The development of the details of this aspect of the retrofit would lead to numerous obstacles which were not sufficiently addressed by Tetra Tech.

Required Operation of the Auxiliary Saltwater System (ASW)

The safety related ASW system (which cools the spent-fuel-pool system and must be available for emergency heat dissipation) is required to operate even when both units are shut down. The ASW piping is intertwined with the circulating water conduits in the area in front of the turbine building where the cooling tower piping tie-ins are proposed. The safety related ASW power and control conduits also traverse this area. Additionally, a portion of the ASW piping for each unit is integrated with the circulating water conduits. Any retrofit of the ASW system to a closed-cycle cooling configuration would significantly increase heat exchanger inlet water temperatures outside of existing design parameters. This safety system design challenge would likely present an insurmountable feasibility issue if this system was placed on closed-cycle cooling. Tetra Tech did not adequately address issues regarding either maintaining or retrofitting the ASW system which has both nuclear licensing and technical feasibility implications.

Comments on Section 3.4 — Environmental Effects

Air Emissions

Tetra Tech states that state-of-the-art drift eliminators are included in the study for each cooling tower cell at DCPP. However, a significant amount of salt would be deposited on the DCPP site by the towers. Tetra Tech does not address the impact of these salt deposits on equipment degradation, maintenance costs, the environment, or the increased occurrence of electrical arcing of the 500kV lines. The NRC would have an interest in the increased potential for tripping the plant due to arcing. Salt deposition could have a significant impact on the degradation and maintenance requirements of nuclear safety related systems. This issue must be further analyzed to quantify its nuclear safety impact before making any determination of feasibility.

Make-up Water

Tetra Tech's use of one existing Circulating Water Pump for tower make-up is unworkable. Tetra Tech's conceptual design is that "one circulating water pump rated at 207,000 gpm, which is currently used to provide once through cooling water to the facility, will be retained in a wet cooling system to provide makeup water to both cooling towers."

Tetra Tech further states that, "The capacity of the retained pump exceeds the makeup demand capacity by approximately 130,000 gpm. Any excess capacity will be routed through a bypass conduit and returned to the intake forebay. Instituting a diversion as outlined in Figure C–7 may not be practical for DCPP given the large volume of water that would be recirculated. New makeup water pumps would represent a marginal increase in capital and installation costs compared with the total value of the project."

The present circulating water pumps are rated (design point) at 433,000 gpm @ 96.5 feet Total Differential Head (TDH), not 207,000 gpm as stated by Tetra Tech. At the higher discharge head required to feed the cooling tower system, the pump would be operating at or near its shut-off point, may not be able to supply the required make-up flow and would be in danger of destroying itself. (Pump shut-off head is 160 ft, pump head at 207,000 gpm is 132 feet, cooling tower basin water elevation is roughly 140 to 150 feet, CT riser elevation is roughly 190 feet.) With one unit shut down this technically unacceptable condition would be made worse. Additionally, a design in which two 1100 MW plants are dependant on a single pump (especially one pump operating away from its design point) is technically and commercially unacceptable. Four new make-up water pumps would be required. The new pumps with associated intake structure, power supply, controls, etc., would be a significant increase to the cost and complexity of the total project.

NPDES Permit Compliance

The remaining discharge of at least 72 million gallons per day is not adequately analyzed. This discharge would be significantly warmer and saltier than the existing power plant discharge and may also contain other contaminants used to keep the cooling system operational. This anticipated minimum tower system discharge cannot be permitted without significant treatment. Yet the report's analysis suggests that capital costs to provide such treatment would be under $400,000 – clearly an insufficient amount for such a large volume of brine discharge. Another significant issue is that receiving waters offshore of Diablo Canyon have ambient temperature ranges as low as 48-52 degrees Fahrenheit for extended periods of time. The draft report does not analyze the overall plant system discharge temperatures following a retrofit and it is unclear how the facility would meet State Thermal Plan requirements during routine operations. Additionally, the analysis appears to suggest that maintenance costs would be on the order of $0.5 per gallon, which would equate to $35 million dollars a year—but this amount is not included in annual operations and maintenance figures.

Thermal Efficiency

Tetra Tech states that the use of wet cooling towers at DCPP will increase the temperature of the condenser inlet water by 17 to 20° F above the surface water temperature, depending on the ambient wet bulb temperature at the time. Backpressures for the once-through and wet cooling tower configurations were calculated on a monthly basis using ambient climate data. "In general, backpressures associated with the wet cooling tower were elevated by 0.70 to 0.85 inches HgA compared with the current once-through system (Figure C–10 and Figure C–12)." Tetra Tech gave no further basis or details of their calculations.

Our preliminary calculation using an increase of 18°F for the cooling tower configuration and an ocean water temperature of 55°F to 60°F indicates an increase of 0.85 to 1.0 inches HgA backpressure versus the 0.7 to 0.85 inches HgA calculated by Tetra Tech.

Comments on Section 4.0 — Retrofit Cost Analysis

Shutdown Timeframe is Not Accurate

There are two key issues with this analysis. First, an eight-month shutdown is not a reasonable estimate. For a project of this complexity, our professional judgment is at least one year, and more likely 18 months, would be required. We agree with footnote 5 on page C-24, which indicates that Diablo's importance to the grid would require a staggered conversion, but that such a conversion is not possible given the existing configuration of the facility.

Additionally, the cost of replacement power is incorrectly calculated using a merchant generator model. For a utility such as PG&E, replacement power must be purchased to make up for the loss of generation. In this circumstance, there is no netting against cost savings, except for savings in fuel costs. Due to labor agreements and other issues, there are no savings in labor or other expenses when Diablo Canyon is not operating.

In addition, the assumed cost of replacement power of roughly $65/MWh is considerably understated. A fairer average cost to purchase power on the surplus market would be the market price referent (MPR) of approximately $96/MWh. The MPR is a CPUC-set benchmark price at or below which approved contracts will be considered *per se* reasonable. At this level, the cost of replacing lost generation would be closer to $960 million, which would be offset by only approximately $66 million in fuel savings. Thus, the costs associated with lost generation due to a conversion shutdown would be closer to $894 million assuming the 8-month period estimated by Tetra Tech. However, estimates by Burns Engineering in reviewing the Central Coast Regional Water Quality Control Board's 2002 study by Tetra Tech and our further research indicates that a shutdown in the range of 12-18 months is more likely, leading to a total cost for replacement power in the range of $1.3 - 2.0 billion.

Operations and Maintenance

The draft report includes annual estimates of operations and maintenance in the range of $7 to 10 million. This estimate does not include any additional operations and maintenance funding for the necessary water treatment system (estimated to be $35 million per year), likely increased corrosion of plant equipment, and other required system modifications.